

A GENERAL ROUGH-SURFACE INVERSION ALGORITHM: THEORY AND APPLICATION TO SAR DATA

M. Moghaddam

Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

ABSTRACT

Rough-surface inversion has significant applications in interpretation of SAR data obtained over bare soil surfaces and agricultural lands. Due to sparsity of data and large pixel size in SAR applications, it is not feasible to carry out inversions based on numerical scattering models. The alternative is to use parameter estimation techniques based on approximate analytical or empirical models. Hence, two issues to be addressed, namely, what model to choose and what estimation algorithm to apply.

Here, a small perturbation SPM is used to express the backscattering coefficients of the rough surface in terms of surface parameters. The algorithm to estimate these parameters is based on a nonlinear least-squares criterion. The least-squares optimization methods are widely used in estimation theory, but the distinguishing factor for SAR applications is incorporating the stochastic nature of both the unknown parameters and the data into formulation, which will be discussed in detail. The algorithm is tested with synthetic data, and several Newton-type least-squares minimization methods are discussed to compare their convergence characteristics. Finally, the algorithm is applied to multifrequency polarimetric SAR data obtained over some bare soil and agricultural fields. Results will be shown and compared to ground-truth measurements obtained from these areas.

The strength of this general approach to inversion of SAR data is that it can be easily modified for use with any scattering model without changing any of the inversion steps. Note also that, for the same reason, it is not limited to inversion of rough surfaces, and can be applied to any parameterized scattering process.

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